ELECTRON EXCITATION CROSS SECTIONS FOR THE
$3p^5\,{}^2P^{\circ}_{3/2} \rightarrow 3p^5\,{}^2P^{\circ}_{1/2}$ FINE STRUCTURE TRANSITION IN Fe^{9+}

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The ground-state fine-structure transition $3p^5\,{}^2P^{\circ}_{3/2} \rightarrow 3p^5\,{}^2P^{\circ}_{1/2}$ in Fe^{9+} can be observed over the cool solar corona ($T \approx 2 \times 10^6\,K$) and in sunspot regions ($T \approx 4 \times 10^6\,K$). In general, the lines in FeIX-FeXIV are important diagnostics of the electron temperature (T_e) and density (N_e) in different solar regions and features. A summary of the use and theory of this so-called coronal red line can be found in Mason[1].

In order to convert line intensities to actual T_e and N_e one needs reliable theoretical or experimental data. For almost all ionic species, for practically all charge states and transitions, only theoretical data are available, with no comparison to absolute, or even normalized, experimental cross sections. Presented herein are experimental measurements of absolute collisional excitation cross sections for the $^2P^{\circ}_{3/2} \rightarrow {}^2P^{\circ}_{1/2}$ transition. Comparison is given with the recent results in a 49-state Breit-Pauli R-matrix calculation of Tayal[3] for this transition.

The experimental measurements were carried out using the 14.0 GHz electron cyclotron resonance ion source at the JPL HCI Facility[4-6]. The Fe^{9+} ions were generated from ferrocene vapor, and extracted at 9×6.4 keV from the ECR. The metastable fraction was determined from the gas attenuation technique. The fraction was determined for the different daily ECR running conditions, and applied to the measured cross sections.

Present absolute excitation cross sections are shown in Fig. 1. Comparison is given with results in the 49-state Breit-Pauli R-Matrix calculation[3]. Here, the theoretical data were not (yet) convoluted with the 100 meV (FWHM) electron-energy resolution of the electron gun, so that the strong, sharp resonance structure is intact. From the preliminary data, one sees in Fig. 1 good agreement between present absolute measurements and the Breit-Paul theoretical results. There is evidence for the broad, strong resonance at 4.5 eV, and the weaker structure at 5.25 eV. Work is in progress to acquire data in a finer energy step throughout the energy range 1.94-6 eV.
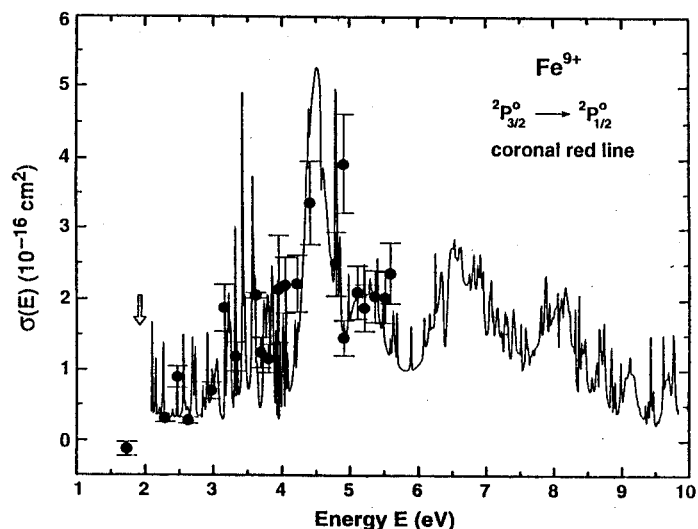
Figure 1. Comparison of present absolute experimental cross sections for the Fe^{9+} coronal red line transition λ 6376 Å (solid circles), with (uncovoluted) results in the 49-state Breit-Pauli R-Matrix calculation (dashed line)[3]. Vertical arrow denotes the threshold at 1.94 eV.

References

1. H. E. Mason, At. Data Nucl. Data Tables **57**, 305 (1994).

2. S. S. Tayal, Ap. J. Suppl. Ser. **132**, 117 (2001).

3. S. S. Tayal, Ap. J. **544**, 575 (2000).

4. A. Chutjian, J. B. Greenwood, and S. J. Smith, in Applications of Accelerators in Research and Industry (ed. J. L. Duggan & I. L. Morgan, New York: AIP, 1999).

5. J. B. Greenwood, S. J. Smith, A. Chutjian, and E. Pollack, Phys. Rev. A **59**, 1348 (1999).

6. J. A. Lozano, M. Niimura, S. J. Smith, A. Chutjian, and S. S. Tayal, Phys. Rev. A (in press).

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